N 27.2:Su3

The New Navy
ANTI-BLACKOUT SUITS

Improved, Light Nylon Zoot Suit Prevents Black-out When Fighter Pilots Pull High G's in Combat

AVIATION TRAINING DIVISION • OFFICE OF THE CHIEF OF NAVAL OPERATIONS • U. S. NAVY • NAVAER 00–80V–67

Z–3 cutaway type suit has air bladders of plastic-impregnated cloth—two over calves, two over thighs, and one over abdomen. Wearer puts suit on the right leg.

ANTI-BLACKOUT SUITS

SOME FACTS ABOUT "G"

When a flyer pulls out of a dive or makes a steep turn, his body feels the effects of positive G. Blood rushes from his head to his feet and tends to pool there. If G forces affect him long enough, his heart does not receive enough blood to pump to his brain, and the flyer *blacks out*. Sufficiently strong and sustained G will cause him to *lose consciousness.*

Sustained G is the particular enemy of the fighter pilot. Fear of blacking out may hamper his flight maneuvers so drastically that he may lose a sure kill. Sustained G, even when it doesn't black-out a pilot, will fatigue body and mind.

Sustained G is any high amount of G extended more than 4 or 5 seconds. Most pilots:

1. Begin to *gray out* at about four to five sustained G's;
2. *Black-out* at about five to six sustained G's;
3. *Lose consciousness* around six to seven sustained G's.

It is not uncommon during the stress of combat to reach relatively high amounts of sustained G. That is why the physical and psychological effects of these forces are serious aviation problems.

The solution, of course, is in checking the rapid flow of blood from the head to the feet during the period when G forces are at work. The Navy's aviation medical specialists have produced a device to do the job safely—the "Z" suit.

The Anti-blackout, or Z, suit consists of a bladder system and supporting garment inserted into a pressure line. When G forces are exerted, the bladders inflate against the legs, thighs, and abdomen, retarding the downward flow of blood. As the pressure of the suit is increased, the pilot is given increased protection against graying out or blacking out.

The Z suit increases the pilot's tolerance of sustained G. A pilot wearing it can pull six-and-a-half G's for as long as 30 seconds without graying out or blacking out. Normally, no pilot could pull this many G's for more than a second or two without losing consciousness.

Another point about the Z suit: Usually, pilots returning from repeated maneuvers involving high G forces are greatly fatigued. Even low G forces repeated during a long flight produce mental confusion and slowed reaction at the time and weariness later. The pilot who wears a Z suit is less fatigued after such manuevers and maintains a higher degree of combat efficiency throughout the flight. In fact, the suit is often called the "antifatigue" suit because it provides support in the relatively low G range where black-out does not occur but straining is still necessary. The suit eliminates straining.

The Z suit is a practical piece of equipment. All the pilot has to do is put it on and plug it in. The G valve admits air pressure according to the amount of G being exerted; and when G ceases, the air is quickly vented from the suit. Even when fully inflated, the Z suit does not interfere with the pilot's movements.

As accessory flotation gear the inflated Z suit provides almost as much buoyancy as a Mae West. The pilot unzips the legs of the suit by means of the quick release zippers on the upper thighs and snaps them together behind his back.

Then he removes the "whistle" from the left breast pocket, inserts it into the inflation tube, and inflates the suit. Of course, the Z suit is *not* intended to replace a life jacket. It should be used only for additional buoyancy.

CAUTION

The Z suit does not make a pilot a superman. What it does is to make him a better G man to the average extent of one-and-a-half G's—*but* it has this effect only during sustained G. Sudden G, regardless of the amount, does not black-out a pilot if it lasts for only 1 or 2 seconds. Indeed, sudden G is harder on the plane than on the pilot. A plane is designed to withstand only a certain number of G's, and when this is exceeded, even for a second, structures may give way. It is the amount of G *and* its duration—over 4 to 5 seconds—which affect the pilot. The amount of G, *regardless of duration,* affects the plane.

All pilots must know the structural limitations of their planes. Wearing the Z suit does not change in any way the amount of G the plane can withstand. That is why a pilot should *not* wear the Z suit in combat until he has used it during training flights in planes equipped with accelerometers. He must constantly check the "feel" of the suit with accelerometer readings until he can estimate the number of G's being pulled by the amount of pressure in the suit.

Note that pilots wearing the Z suit do not feel encouraged to pull more G than their planes can stand. At the Patuxent Naval Air Station, conclusive tests on the flyers of an air group in training proved they pulled no more G's while wearing the suits in regular training maneuvers than when flying without them. The fact is, an alert pilot in full possession of his mental faculties is less likely to subject himself and his plane to extreme G than one who is dazed and groggy. Pilots in the habit of "jinking" and making snap maneuvers of short duration to avoid black-out find that the suit allows them to fly more smoothly, prolong their pull-outs, and pull less G. In a sense, the suit protects the plane as well as the pilot.

Pilots require proper tactical indoctrination and training in the use of the Z suit. The Dilbert who tries to see how high he can hoist the accelerometer reading is the kind of pilot who will pull his plane to pieces whether or not he wears a Z suit. But proper training in using the suit results in smoother flying, greater safety, better tactics, and clearer heads.

All fighter pilots should see the film *"G" and You,* and familiarize themselves with

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"G" Sense

TYPES OF Z SUITS

Two Z suits are now available for VF, VBF, and VMF pilots—the Z–2 and the Z–3. A third type, the Z–1 coverall, was replaced by the Z–2.

THE Z–2 SUIT. A nylon coverall, the Z–2 is hardly distinguishable, when uninflated, from the standard fighter pilot's summer flying suit. It has a total weight of less than 3 pounds.

The bladders and tubes within the suit are made of nylon, impregnated and coated with vinyl resin, with coiled wires to keep them from collapsing. The wire itself is covered with a nylon screen to prevent abrasion of the surfaces. There is no

New model zoot suit slips on easily.

rubber in the bladders or tubes. The bladder system is connected on the left side of the suit to a tube fitted with a metal male plug which joins a female quick-disconnect, mounted in most airplanes on the left side of the pilot's seat.

THE SKELETON TYPE Z–3 SUIT. When pilots wear uniforms or other clothing in flight, the coverall type Z suit may not be practical. A skeleton type Z suit has therefore been designed for such circumstances. The Z–3 has the same kind of bladders as the other suit and gives almost the same protection when properly fastened to the body by the quick adjustable lacings. The Z–3 may be worn over or under *light* clothing; but it must be worn under *heavy* clothing. It is not recommended for tropical wear. The Z–2 or Z–1 is the proper suit for hot climates.

PRESSURIZING EQUIPMENT

The Valve

1. OPERATION. Pressure for the Z suit is supplied from the exhaust side of the vacuum instrument pump. Regulation is controlled by a valve which admits varying pressure into the suit in proportion to the amount of G. When G is exerted, a weighted plunger within the valve is forced downward against a spring. The movement of the plunger opens a port. Air enters the suit through the port until

Suit is similar to ordinary coverall.

Wearer finds new anti-blackout suit easy to adjust. Suit's zipper speeds action.

back pressure, acting on the bottom of the plunger, raises it and so shuts the port. As the G force acting downward on the plunger increases, a greater pressure from the suit is required to raise the plunger.

Any G in excess of 1.8 will actuate the valve and admit the proper pressure. Regulated by the valve, pressure enters the suit at the ratio of 1 pound per G, starting at 1.8 G. At 2.8 G, for example, there will be a pressure of 1 pound; at 3.8 G, a pressure of 2 pounds; and so on.

2. MINOR VALVE REPAIRS.

a. A sticky new valve may cause a sudden rush of air into the suit. Loosen the valve once or twice.

b. The valve may function improperly if not mounted vertical to the line of flight. The mounting bracket must not be bent or loose.

c. When the pilot is not wearing his Z suit, the blank plug fitting the female quick-disconnect should be plugged in to block off air from the vacuum instrument pump. Otherwise a blast of air will shoot through the cockpit whenever the plane is in a maneuver producing more than 1.8 G.

THE VACUUM PUMP AND OIL SEPARATOR. Suction for fighter plane instruments is provided by the vacuum instrument pump. Before Z suit installations were made, the positive pressure from the pump was not used at all, simply passing through an oil separator and then overboard. Now this positive pressure inflates the Z suit by passing through the G-operated valve.

Inadequate Z suit pressure at altitudes of from 15,000 feet up is generally traceable to the instrument pump. After making certain the G valve is working properly, use the following check procedure:

1. Inspect the oil separator and make sure that the oil drain orifice is not too large. The maximum diameter must be 0.070 inches, but some old separators have openings as large as 0.13 inches. A larger size produces too great a pressure drop and is therefore unsatisfactory. Change to the smaller size.

2. If further tests still show unsatisfactory pressure, install a new B2B vacuum pump. It may be necessary to replace the B2B with a B3B pump. The B3B should be used in any case if the plane is to be maneuvered above 20,000 feet.

THE SEAT QUICK-DISCONNECT. Accidental disconnects of the tube and coupling can be serious. The disconnect should be located *behind* the safety belt attachment, never in front. Snarling the suit tube in the safety belt or letting the tube get caught under it must be avoided. When the female part of the disconnect is too loose, the springs should be removed and the holes for the ball bearings slightly enlarged. The insertion of an extra leaf spring also makes for a tighter fit. To reduce undue leverage on the disconnect, the stiffness should be worked out of the tube by hand, especially around the disconnect itself. A new disconnect, loose in its socket, is replacing the older fixed type, and will prevent accidental disconnects.

FITTING THE Z SUIT

Z suits are available in the following sizes:

Size 34—Medium (waist 25″–27″)
Size 36—Short and long (waist 27″–29″)
Size 38—Short and long (waist 30″–32″)
Size 40—Short and long (waist 33″–35″)
Size 42—Medium (waist 36″–38″)
Size 44—Medium (waist 39″–41″)

A poorly fitted Z suit will not give a pilot the protection he needs. Improper bladder pressure around the waist can be extremely uncomfortable, and inadequate leg pressure may result in painful swelling of the veins.

WAIST. The fit of the waist is most important. It should be snug, but not uncomfortably so. Note that the coverall suit is designed to fit a seated pilot, which accounts for the looseness of the seat and a slight tightness of the front when the wearer is standing.

LEGS. In long-torso Z–2 suits, the leg section containing the bladders is 29½ inches long. Short-torso Z–2 suits have leg lengths of 27½ inches. Leg diameters of the Z–1 were made to fit the largest thighs and calves relative to waist sizes, and may need alterations by the parachute rigger for thin-legged pilots. The bladders will exert the necessary leg pressure if no more than 1½ to 2 inches of surplus cloth can be grabbed between the fingers, leaving the leg fit comfortably loose, not skin tight. See Technical Note 56–45.

Inflated suit is still comfortable.

The legs of the Z–2 suit usually do not need changing, but an odd-sized pilot may find a suit too tight in the legs even though it fits his waist and chest. Alteration can be effected with either of the two sizes of zipper inserts—the ¾- or 1½-inch.

Fit can be double-checked by having the pilot sit in the position he assumes when he flies his plane, and inflating the suit to a pressure of 2 to 3 pounds per square inch. The inflated bladders should compress the calves and thighs firmly and evenly.

NOTE.—In hot weather a pilot may wish to unzip his Z suit partially when immediate need for anti-G protection is unlikely. Any parachute rigger can install from one to three snaps along the inside of the zipper flap to hold the flaps together when the zipper is loosened.

CARE AND REPAIR

The Z suit is rugged enough to be handled like any other piece of flight clothing except for two simple precautions:

1. The suit should be hung on a coat hanger after use;

2. It should be laundered and repaired with more than usual care because of the tube and bladder installations.

LAUNDERING DIRECTIONS. Before using any water on the suit, close the opening of the external connection tube to prevent water from getting in the bladders. Wash the suit in lukewarm water—never to exceed 120 degrees. Wash by hand only. Do not scrub the sections containing bladders. Never iron the suit because excessive heat will damage the bladders.

A suit that has been soaked in salt water requires special treatment. Rinse several times in fresh water; wash in lukewarm water; and allow the suit to dry. If salt water has penetrated the bladders, rinse once with fresh water; then, following the curve of the bladders, drain out all water and allow to dry. Note that though a small amount of oil from the vacuum instrument pump may collect in the bladders, the oil-resistant vinylite coating makes it harmless.

SUIT REPAIR. Full directions for repair of torn suits and bladders are given in TN 56–45 and the suit maintenance kit.

PROCUREMENT AND DISTRIBUTION

Z suits are distributed by ComAirPac and ComAirLant on the basis of one per VF, VBF, and VMF pilot. Initial distribution of Z–1 suits is no longer being made. If additional Z–2 suits are desired, request should be made to ComAirPac, ComFairWestCoast, or ComAirLant. Sizes and stock numbers are given here for convenience in ordering.

Size 34 Medium	R37–S–4841–34
Size 36 Medium	R37–S–4842–36
Size 36 Long	R37–S–4840–36
Size 38 Short	R37–S–4842–38
Size 38 Long	R37–S–4840–38
Size 40 Short	R37–S–4842–40
Size 40 Long	R37–S–4842–40
Size 42 Medium	R37–S–4841–42
Size 44 Medium	R37–S–4841–44

Installation kits may be requested in the same way for the following aircraft:

F4U	R82–K–F4U–CH210
FG	R82–K–FG–CH210
F6F	R82–K–F6F–CH85
FM2	R82–K–FM2–CH55

The Installation Maintenance Kit order number is R82–K–613950.

The Suit Maintenance Kit order number is R37–K–450.

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